National Severe Storms Laboratory (NSSL)

Contact persons:

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1.) Please provide a copy of the most resent evaluation of the lab or center in pdf format .

* NSSL has had the following reviews in recent years

Internal "Mini-Reviews":

a) May 11, 2000 – Administrative, budget, planning review
b) June 4, 2002 – Administrative, budget, planning review

External Review:

a) June 23 & 23, 1999 – Scientific lab review (* See attached .pdf)

2.) Please provide a brief history, and mission of your laboratory /center.

Mission

The mission of the National Severe Storms Laboratory (NSSL) is to enhance the NOAA's capabilities to provide accurate and timely forecasts and warnings of hazardous weather events (for example, blizzards, ice storms, flash floods, tornadoes, and lightning). The mission is accomplished in partnership with the National Weather Service (NWS), through a balanced program of research to advance the understanding of weather processes; research to improve forecasting and warning techniques; development of operational applications; and the transfer of understanding, techniques, and applications to users.

Brief History

NSSL was formed in 1964 as an outgrowth of the Weather Bureau's National Severe Storms Project (NSSP). NSSP was part of the Severe Local Storms Forecasting unit after the unit moved to Kansas City, Missouri, from Washington, D.C. A field site was soon established on the former North Base, U.S. Naval Air Station, Norman, Oklahoma. This site later became the NSSL headquarters. During its early life, NSSL was principally a radar development laboratory and field observational facility for the Weather Bureau, which became part of the Environmental

Science Services Administration (ESSA) in 1965 and, finally, NOAA in 1970. NSSL is now co-located with the Norman NWS Forecast Office, the Storm Prediction Center of the NWS National Centers for Environmental Prediction (NCEP), the NWS NEXRAD (WSR-88D), Radar Operations Center, and the NWS Warning Decision Training Branch.

What does the National Severe Storms Laboratory do for the nation?
The National Severe Storms Laboratory (NSSL) leads the way in investigations of all aspects of severe and hazardous weather. Headquartered in Norman, Oklahoma, the people of NSSL, in close partnership with the National Weather Service, are dedicated to improving the lead-time and accuracy of severe weather warnings and forecasts in order to save lives and reduce property damage. Severe weather research conducted at NSSL has led to substantial improvements in both severe and hazardous weather forecasting resulting in increased warning lead times to the public. NSSL scientists are exploring new ways to improve our understanding of the causes of severe weather and ways to use weather information to assist National Weather Service (NWS) forecasters, as well as Federal, university and private sector partners.

Financial Profile (Dollars in Thousands)

Fiscal Year		Permanent Funding	Other NOAA	Non-NOAA	Pass Through		TOTAL
	FY 2001	5898.5	2341.9	6821.2	1051.1		16112.7
	FY 2002	6357.0	4379.0	5828.0	420.0		16984.0
	FY 2003	6437.5	4022.6	5005.1	548.8		16014.0

3.) Please provide a listing of major customers of the laboratory /center, with a one sentence description of what is being done for them.

Oceanic & Atmospheric Research Laboratories

a) Forecast Systems Laboratory – NSSL collaborates on projects with the Central Weather Bureau and Water Resources Agency of Taiwan to develop a Hydrometeorological Decision Support System (HDSS) for Taiwan with the goal of improving the country's capabilities to issue flash flood and flood warnings and to improve their river and reservoir water management.
b) Environmental Technology Laboratory – NSSL assists in the development of a hydrometeorological testbed within NOAA.

National Weather Service

a) Radar Operations Center – NSSL provides engineering-based improvements to the NEXRAD radar system (e.g., open systems platform) and develops advanced "next generation" weather radar systems for the NWS such as dual polarized radar.
b) Weather Forecast Offices – NSSL provides science-based products, such as, combining or mosaicking several NWS radars together, along with other data (e.g., satellite, lightning, model, etc.), to produce broad, county warning area views supporting forecasters in the severe weather warning process.
c) National Centers for Environmental Prediction (Storm Prediction Center) – NSSL conducts joint collaborative forecast/research efforts to improve forecasting, to develop new techniques such as probabilistic forecasts or winter weather products, and explore promising applications of numerical models in forecasting severe weather (e.g., the use of Short-Range Ensemble Forecast (SREF) prediction systems and the use of high-resolution deterministic models).
d) National Centers for Environmental Prediction (Environmental Modeling Center) – NSSL conducts research to support operational modeling, for example, a recent project provided a preliminary assessment of the forecast value of high resolution models compared to the current generation of operational and experimental forecast models, including the Weather Research and Forecasting model, Eta, EtaKF, RUC, and NCEP's new Nonhydrostatic Mesoscale Model.
e) Office of Hydrologic Development – NSSL's growing collaboration with the Hydrologic Development Laboratory is designed to improve hydrologic modeling and to transfer technology for improving estimation of precipitation using radar-centric, multi-sensor applications.
f) Warning Decision Training Branch – NSSL provides scientifically grounded, background material for training activities for improving basic and advanced WSR-88D operator proficiency, with an emphasis on the integrated data environment, warning methodology and situation awareness.
g) Office of Science and Technology – NSSL has an ongoing mission to transfer technology to the NWS under the NEXRAD Product Improvement (NPI) Program and has recently helped to deliver high-resolution radar data from the national network of 142 NEXRAD radars over the Internet in near real-time for government, university and private sector users.

Federal Aviation Administration

a) Phased Array Radar – NSSL is helping jointly fund this radar testbed to enable meteorologists and engineers to determine not only if phased array radar will become the next significant technology advancement to improve our nation's weather services, but if this technology can have a dual-use of also tracking uncooperative aircraft for the FAA.
b) Aviation Safety, NEXRAD Improvements – NSSL is conducting research to predict thunderstorm behavior around airports as it relates to aviation safety.

Navy

a) Phased Array Radar – NSSL is assessing whether technology that was originally used by Navy ships to protect naval battle groups from missile threats can be used as the next significant technology advancement to improve our nation's weather services and whether the Navy can use any weather technology enhancements on their existing shipboard radars.

Air Force

a) NEXRAD Improvements – NSSL provides engineering-based improvements to the NEXRAD radar system as it relates to the Air Force implementation (e.g., open systems platform, specifically the Open Principle User Processing).

Private Sector

a) CRADAs with private companies to perform joint research on the development algorithms and decision support systems for both severe weather and flash floods.

4.) Please provide a summary of research being conducted (Your list of major requirements from the Program Baseline Assessments (PBA) may be helpful in answering this question.)

4a. For each research theme identified above, include a brief explanation of how this research relates to NOAA program areas. (The program areas are those identified in the recent Program Baseline Assessment.)

4b. Provide the geographic scope of your research - regional, national, global.

4c Provide the time frames of your research - short term, (0-2 years), medium term, (2-5 years), long term (greater than 5 years).

4.1) Phased Array Radar (PAR) – This program is a major component of the severe weather technology development research conducted in NOAA to improve the lead times for severe weather warnings including thunderstorms, tornadoes, and flash floods. The primary tool for early warnings is the weather radar. Over the last two decades with the implementation of Doppler capabilities, the weather radar has helped improve warning lead times from near zero to nearly 11 minutes on average for tornadoes. NOAA's goal is to increase these lead times. The PAR program has a plan for NOAA over the next ten years to develop new technology that would improve effectiveness of observing systems. The improvements will consist of classification of precipitation type including better detection of hail and snow, improved measurements of precipitation, increased accuracy and amount of lead time of tornado detection, and increased accuracy and amount of lead time of flash floods. The PAR technology consists of an array of multiple radar pulses operating at varying frequencies to create the best image of the surrounding atmosphere. The radar will include new adaptive scanning strategies whereby the regions of most interest (favored regions for tornado formation, flash flood production, hail generation) would be thoroughly scrutinized while still giving proper attention to regions of benign weather. All this will be done at volume update rates five to ten times faster than the current weather surveillance radars. This radar system will be suitable for multiple mission objectives, including those of the FAA, DoD, and the Office of Homeland Security. The program is a cooperative effort among NOAA Line Offices, the Office of Naval Research (ONR), the Federal Aviation Administration (FAA), University of Oklahoma (OU), Oklahoma State Board of Regents for Higher Education, and private partners.

4.1.a Relation to NOAA program areas - Supports NOAA Strategic Planning Mission Goal 3; serve society's needs for weather and water information. Specifically, NSSL contributes to the Understand and Describe strategy, investing "in new technologies, techniques, and weather and water forecast modeling to improve the accuracy and timeliness of NOAA's prediction capabilities and services."

4.1.b Geographic Scope – National to global.

4.1.c Time frame – Long term (15-20 years)

4.2) Radar Meteorology – Weather surveillance radar technology is at the core of the NSSL mission and critical to NOAA's mission for the protection of life and property. NSSL was responsible for the scientific development of the WSR-88D (NEXRAD) radar system beginning in the early 1970s. NSSL is supporting the National Weather Service and the NEXRAD WSR-88D radar program in the continued improvement of severe weather performance metrics. NSSL is also finalizing the prototype development, assisting in the deployment, and providing technical updates for the new dual polarized radar upgrade for the WSR-88D radar scheduled in FY08. NSSL accomplishes this with a small core of Federal scientists and engineers to lead NOAA's weather surveillance radar program, with substantial collaboration with the university community through NOAA's Joint Institutes.

One of NSSL's immediate goals is to increase warning lead times for tornadoes from 12 to 18 minutes, thunderstorms from 15 to 22 minutes and flash floods from 52 to 60 minutes. Longer term research plans include;

FY04 - Development of range over-sampling techniques with whitening and completion of the first phase of a technique for full power spectrum processing at each range gate. Researchers will use the full power spectrum to develop pattern recognition applications for tornadic vortex identification; will support development of requirements for NEXRAD implementation of dual polarization; will begin proof-of-concept activities of dual polarization data usage in Radar Product Generator; and will begin research on X-band dual-polarized low cost radars for boundary layer observations.

FY05 – NSSL will continue research on range over-sampling, with whitening and full power spectrum processing pattern recognition; will develop techniques to utilize data from extending Doppler processing to the end of the second trip; will begin development of techniques for using velocity and spectrum width estimates from low-level surveillance scans; and will perform comparison studies of X-band low cost radars and develop multi-radar database for providing the best information to the user.

FY06 – NSSL will prepare dual-polarization algorithms for transfer to operations; will continue to improve radar data quality and implement Range/Velocity Ambiguity mitigation techniques in operational system.

FY07 – Researchers will implement dual-polarization on the NWS operational NEXRAD system and will continue evaluation of a multi-radar database using X-band, WSR-88D, Phased Array and other radars.

FY08-10 – NSSL will develop and test techniques to improve the WSR-88D (Projects will depend upon NWS current needs).

4.2.a Relation to NOAA program areas - Supports NOAA Strategic Planning Mission Goal 3; serve society's needs for weather and water information. Specifically, NSSL contributes to the Understand and Describe strategy, investing "in new technologies, techniques, and weather and water forecast modeling to improve the accuracy and timeliness of NOAA's prediction capabilities and services."

4.2.b Geographic Scope – National to global.

4.2.c Time frame – Algorithm development (short term); NEXRAD radar upgrades and support; polarized radar upgrade to NEXRAD (short, medium, and long term); Polarized radar research and continued development (long term)

4.3) Radar-centric, Multi-sensor hydrometeorology – NSSL is engaged in the development of radar-centric, hydrometeorological approaches for substantially improved quantitative precipitation estimation (QPE) built upon new WDR-88D polarized radar in collaboration with National Weather Service's Radar Operations Center in support of flash flood forecasts and warnings and hydrometerological services. Supported solely through reimbursable funding, NSSL conducts the Hydrology Program through its expertise in radar meteorology and the development of new techniques for observing precipitation amounts (hydrometeors). NSSL is refining polarized radar techniques for inclusion in NOAA's WSR-88D Radar program in FY07 and FY08. NSSL is working with the NWS Office of Hydrologic Development to test various approaches that utilize these radar-based precipitation estimates to improve flood and flash flood forecasts and warnings. The program includes substantial collaboration with the NWS OHD and the university community through NOAA's Joint Institutes.

4.3.a Relation to NOAA program areas - Supports NOAA Strategic Planning Mission Goal 3; serve society's needs for weather and water information. Specifically, NSSL contributes to the Understand and Describe strategy, investing "in new technologies, techniques, and weather and water forecast modeling to improve the accuracy and timeliness of NOAA's prediction capabilities and services."

4.3.b Geographic Scope – National to global.

4.3.c Time frame – Algorithm development is short term (algorithms are ready for operational testing now), medium term (new algorithms are being developed to take advantage of newer technology), and long term (development of algorithms to use polarized radar and PAR)

4.4) Stormscale Ensemble Modeling (initialized using high-resolution radar data) – NSSL is working to sustain and advance the nation's observational severe weather capability, to explain the observations with sound scientific theoretical and mathematical principles, and to simulate the observed severe weather using numerical models initialized with high-resolution data. Specifically, NSSL researchers are working to solve the tornado dynamics problem (how tornadoes form and dissipate) using models (both theoretical and numerical) initialized using data from mobile radar, mobile observation stations, polarized radar, and phased array radar. NSSL plans to lead a focused field program with national participation from universities, other government organizations and NCAR (e.g., upcoming VORTEX-2 field program) to address these types of issues that have direct impact upon NOAA's and NWS's ability to provide severe weather forecasting and warning services to the public.

In addition, NSSL continues to research techniques, such as the use of ensembles, to improve forecasts of severe and hazardous weather for use by the NWS's National Centers for Environmental Prediction (NCEP). The program includes a small core of Federal scientists leading NSSL's modeling and mobile observation research in support of NOAA's numerical modeling program with substantial collaboration with the NWS's NCEP and the university community through NOAA's Joint Institutes.

4.4.a Relation to NOAA program areas - Supports NOAA Strategic Planning Mission Goal 3; serve society's needs for weather and water information. Specifically, NSSL contributes to the Understand and Describe strategy, investing "in new technologies, techniques, and weather and water forecast modeling to improve the accuracy and timeliness of NOAA's prediction capabilities and services."

4.4.b Geographic Scope – National to global.

4.4.c Time frame – Short term (some experimental ensemble methods are ready for NCEP to test in operations), medium term (high-resolution temperature forecast models are showing some promise and could be available in 2-5 years), long term (ensembles of models and high resolution, radar initiated numerical models will require more than 5 years to develop appropriate data assimilation schemes)

4.5) Severe Thunderstorm, Electricity & Lightning Studies – The goal of this effort is to enhance our understanding electrical properties of storms, as well as tornadoes and the mechanisms that cause tornadogenesis so that we can better predict and warn of tornado occurrences. The approach taken is to collect in-situ data very near storms that have the potential to produce tornadoes so that we can determine why some storms produce tornadoes while others do not. We then analyze these data in conjunction with operational data streams to determine the fundamental causes of tornado production as well as how we can utilize operational systems to predict tornado occurrence. An important goal of this research effort is to learn how lightning and other electrical storm properties are dependent on storm structure, updrafts, and precipitation. This information will point to new ways for the National Weather Service to use lightning observations to improve forecasts and warnings of hazardous weather. Our research utilizes the observation, theory, and models, with an emphasis highlighted on lightning assimilation into forecast models. Other aspects include the search for signatures indicative of severe weather. This effort has a component linked to dual-polarization that can help with understanding cloud microphysics.

4.5.a Relation to NOAA program areas - Supports NOAA Strategic Planning Mission Goal 3; serve society's needs for weather and water information. Specifically, NSSL contributes to the Understand and Describe strategy, investing "in new technologies, techniques, and weather and water forecast modeling to improve the accuracy and timeliness of NOAA's prediction capabilities and services."

4.5.b Geographic Scope – National to global.

4.5.c Time frame – Long term (faster scanning radar, such as Phased Array, could significantly accelerate this research)

4.6) Aviation Safety – The NSSL Multi-radar Composites and Composite Products aim to enhance aviation safety by providing more accurate three-dimensional radar data throughout the Chicago-New York traffic corridor. These data are used by both enroute and terminal Air Traffic Control (ATC) operations, and also by flight airline operations. In anything but ideal weather conditions, aircraft separation, routing, and overall traffic management depend on timely and accurate weather information. These data should also allow air traffic controllers to plan aircraft altitudes and routes further ahead and so reduce their overall task load. An additional benefit is that these data will help plan aircraft operations so as to optimize operational efficiency that will reduce operating costs and enhance passenger convenience.

4.1.a Relation to NOAA program areas - Supports NOAA Strategic Planning Mission Goal 3; serve society's needs for weather and water information. Specifically, NSSL contributes to the Understand and Describe strategy, investing "in new technologies, techniques, and weather and water forecast modeling to improve the accuracy and timeliness of NOAA's prediction capabilities and services."

4.1.b Geographic Scope – National to global.

4.1.c Time frame – medium term

5.) Please provide a listing of 3-5 major accomplishments in the last five years.

Recent Accomplishments:

• NSSL continues to be a pioneer in the development of weather radar. The lab is presently researching the use of dual polarization radar to improve precipitation measurements and hail identification. This upgrade to the current NEXRAD Doppler radar hardware is scheduled to begin deployment in FY2007. Polarized radar provides more information about precipitation in clouds to better distinguish between rain, ice, hail and mixtures. ***Payoffs: Such information will help forecasters provide better warnings for flash floods, the number one severe weather threat to human life.***

• NSSL is dedicated to investigating new approaches for the use of numerical weather prediction models in operational forecasting, with emphasis on the use of ensemble techniques and high-resolution models, in collaboration with the NWS. Scientists at NSSL organized the first short-range ensemble forecasting (SREF) workshop, led the data analysis of the NCEP SREF pilot program, and are pioneers in using both model and initial condition uncertainty in short-range ensembles. This research has strongly influenced the development of a multi-model, multi-physics SREF system for the NWS. NSSL also partners with the Storm Prediction Center in the development of forecast experiments, in which new forecast techniques are developed and evaluated. ***Payoffs: The knowledge and techniques developed provide forecasters with improved numerical forecasts and forecast products, leading to more accurate and skillful forecasts of severe weather***.

• NSSL is committed to incorporating cutting edge scientific understanding of severe weather signatures into tools designed to help National Weather Service forecasters make better and faster warning decisions. The latest tool, NSSL's Warning Decision Support System II, includes automated algorithm detection tools for the NEXRAD Doppler radar and other sensors to identify rotation in storms preceding tornadoes, likelihood and size of hail, as well as simply identifying and tracking storms. This information is presented to forecasters in an easy to use display including tables, graphics, and includes interrogation tools. ***Payoffs: Several of these tools have already been integrated into the National Weather Service's systems and have contributed to improvements in severe warning lead times with fewer false alarms.***

• NSSL worked directly with the National Weather Service to complete a significant upgrade to the NEXRAD WSR-88D Doppler radar. The Open Radar Product Generator's (ORPG) software and hardware were redesigned using open systems concepts, providing a system that is now capable of growing and adapting to meet the ever increasing demands of its users. NSSL was responsible for the design and implementation of the system software architecture. ***Payoffs: The ORPG's redesign allows new science and technology to be transferred to NWS operations more quickly and dramatically lowers both ongoing maintenance costs and future upgrade costs.***

• Scientists from NSSL recently completed several field experiments to study severe and hazardous weather. IPEX, the Intermountain Precipitation Experiment, was designed to improve forecasts of winter weather, especially in the high population growth areas of the western United States. STEPS, the Severe Thunderstorm Electrification and Precipitation Study, focused a number of data gathering tools on thunderstorms in the high plains to better understand how rain and lightning are formed. In 2002, NSSL hosted the International H2O Project or IHOP, one of the largest weather-related studies ever conducted in the U.S. Scientists searched for swaths of

water vapor and wind convergence bands that can fuel heavy rain across the southern Great Plains. ***Payoffs: The knowledge gained through these field programs lead to better forecasts of deadly weather phenomena including tornadoes, lightning, hail, flash floods, heavy snow, ice and freezing rain. NSSL has worked with the NWS Storm Prediction Center to develop new operational forecast products such as probabilistic forecasts and hazardous winter weather products.***

6.) Please provide a summary of legal mandates for the work in the laboratory/center.

The NSSL legal mandate is one supporting NOAA through compliance with the Organic Act of 1890 and the Weather Service Modernization Act of 1992, through providing research and development activities to improve weather and flood forecasting and warnings.

7.) Attached in Excel format is the compilation of financial and staffing data that your laboratory or line office provided. Please verify that data are correct.

Please make the following minor revisions for NSSL in the Financial Spreadsheet:

1) Non-NOAA amount should be **$5.25M**
2) Total should be $**16.26M**
3) Staffing: Federal should be **42** employees
4) Staffing total should be **123**